

THE AUSTRALIAN DEVIL RAY,

Daemomanta alfredi (Krefft),
with remarks on the Superfamily
MOBULOIDEA (Order BATOIDEI).

By GILBERT P. WHITLEY, F.R.Z.S.,
Ichthyologist, The Australian Museum, Sydney.*

(Plate xii. and text-figs. 1-3.)

Devil Rays are giant representatives of the Order of Elasmobranchs, the Batoidei, to which such well known forms as the Stingray, Skate and Eagle Rays belong. They differ from these, however, in possessing two extended fins before the eyes, one on each side of the mouth, into which they serve to guide their food. Because of their large size, specimens are rarely preserved in museums, yet they are apparently fairly common in certain localities at some seasons. There are two very different Australian species: *Mobula diabolus* and *Daemomanta alfredi*.

Recently, when in Queensland, I was fortunate enough to secure a fine specimen of *Daemomanta* for detailed examination, and a description of this specimen, with notes on others which have been recorded from Australia from time to time form the basis of this paper. A less technical account, with illustrations, appeared in The Australian Museum Magazine, vi., 1, 1936.

In the present contribution, I have added a list of the world's species of Devil Rays, giving some of them new names, whilst realizing that probably, in the future, still more species may be recognized than are allowed at present. The generic name, *Aodon*, which has been applied to Devil Rays by some authors, is herein demonstrated to apply strictly to a species of shark.

I desire to express my thanks to those who have helped me during my work on the Australian Devil Ray. Firstly, Mr. Dick Lahou, a Torres Strait islander, residing at Lindeman Island, who killed a Devil Ray for me, and our fellow-workers in the boat at the time: Messrs. Melbourne Ward and Loch Nicolson. Captain A. de S. Nicolson, of Lindeman Island, kindly placed boats at our disposal.

To the Mitchell Librarian and the officers of the Mitchell Library, Sydney, I am obliged for help in looking up old books, newspapers and manuscripts. My colleagues, Messrs. F. A. McNeill and Henry Grant, of The Australian Museum, have given helpful information, and Mr. G. C. Clutton has prepared some excellent photographic illustrations.

Phylum VERTEBRATA.
(Backboned Animals).

Subphylum PLAGIOSTOMATA, nov.
(Sharks, Rays, Ghost-Sharks, etc., with Cartilaginous Skeletons).

Class ELASMOBRANCHII.
(Chondropterygii or Antacea of Early Authors.)

Subclass SELACHII (Sharks and Rays).

Order BATOIDEI (Hypotremata).

(Rays, Skates, Torpedo, Sawfish, etc.)

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Suborder MASTICURA (Centrobrates).
(Stingrays, Eagle Rays, and Devil Rays.)
Superfamily MOBULOIDEA, nov.

This new group-designation is desirable for the Devil Rays, for several reasons. Earlier authors have made irregular attempts to propose family names for these animals, which I regard as separable into at least two families, and they have invented names not in accordance with the practice of utilizing the oldest valid generic name as the root of the family name. The establishing of the status of the earliest generic names in this case has been made difficult by the intrusion of the name *Aodon*, which Jordan and others have used for Devil Rays, but my reason for discarding this name, because it refers to a shark, had better appear here before I pass on to the families of true Devil Rays, the Ceratopteridae and the Mobulidae.

Genus AODON Anonymous, 1798.

Aodon Anonymous, Allg. Lit. Zeit., September 24, 1798, 675. Ex "*Aodon*" Lacépède, Hist. Nat. Poiss., i., 1798, 297, vernac. *Id.* Bosc, Nouv. Dict. d'Hist. Nat., ed. 1, i., "1803" = December, 1802, 511. *Id.* Duméril, Zool. Analyt., 1806, 103 *et ibid* (ed. Froriep), 1806, 103 (example: *massasa*). *Id.* Cuvier & Valenciennes, Hist. Nat. Poiss., i., 1828, 191, *ex* Risso. *Id.* Jordan, Gen. Fish., i., 1917, 55. Logotype, *Squalus messasa* Bonnaterre, Tabl. Encycl. Meth. Ichth., 1778, 13, *ex* "Massasa" Forskal, vernac; following Jordan & Evermann, Rept. U.S. Commis. Fish., 1895, Append. v., 1896, 225. Not *Aodon* Lesson, Compl. Buffon, i., 1828, pl. 3, a genus of whales.

Anodon Agassiz, Nomencl. Zool., Index Univ., 1846, 24 & 27. Emendation for *Aodon* Lacépède. Preoccupied by *Anodon* Smith, 1829, a reptile genus; *Anodon* Oken, 1815, mollusca; and *Anodon* Wagler, 1830, in mammalia—*teste* Nomencl. Anim.

The genus *Aodon* was founded on two species of supposedly toothless elasmobranchs called *Squalus massasa* and *S. kumal* by Forskal (Descr. Anim., 1777, x., Nos. 17 & 19), to which a third species, the "*Aodon cornu*", was added from the *Squalus edentulus* of Brunnich.

The logotype of *Aodon* is *Squalus messasa* Bonnaterre, *ex* Forskal, non-binom., but that species, like the others, is insufficiently characterized, and subsequent authors have even doubted whether a shark or a ray was intended by the original account.

Forskal's account is non-binomial, his names having been properly latinized by subsequent writers.

His definition of the species in question is as follows:—

17. SQUALUS: a) *massasa*, *Djiddae*; *mafreka*, *Lohajae*. Dentibus nullis; pinnis pect. longis. A Charcharia diversus.

[Note that *massasa* and *mafreka* are purely native names and not Latin specific names at all.]

19. c) *kumal*. Dentibus nullis; pinnis pect. brevibus; cirrhis oris quatuor.

On page 20, under *Squalus*, Forskal merely adds the vernacular name *Masasa* in italics and Arabic letters. The meagre details supplied point to some kind of shark rather than a ray, yet one is at loss to account for the toothless condition. The oral cirrhi of *kumal* suggest some kind of Catshark.

Coming now to Brunnich's *Squalus edentulus* (Ichth. Massiliensis, 1768. 6), which was published well before Forskal's work was issued, we read:—

"14. SQUALUS EDENTULUS.

Squalus capite lato, plano, maxillis osseis edentulis, superiore longiore, lateribus capitis prominentibus.

Massiliae piscibus adnumeramus *Squalum* in opposito portu Liburnensi aliquoties captum, cujus caput restat asservatum in Museo Academiae, quae *Pisae* floret, ubi cum venia celeberrimi Professoris Dni Attilii sequentia annotabam:—

Descr.: *Caput* latum, planum, antice quasi truncatum, latera sub oculis prominent duabus laciniis cutaceis longis acutis, et in siccato specimine contortis. *Maxilla superior* longior, intus munita osse transversali, cujus latitudo pollicem fere aequat, superficies limae instar scabra, introrsum membrana laxa continuatur. *Maxilla inferior* cartilagineo-ossea edentula laevis. *Latitudo* capitis circiter 3 spithamas aequat. *Latera* corniformia ultra caput $1\frac{1}{2}$ spithama prominent. *Oculi* laterales magni.

Not. Piscem hunc descriptum nescio. *Bovis* mentionem è genere cartilagineo facit *Salvianus* ejusque descriptionem in secundo suo libro, nunquam edito, frustra promisit. *Squalum edentulum* anno praeterlapso observasse et descripsisse Septentrionis nostri decus, *Nidrosiensium Episcopum S. Venerab. Dnum Gunnerum* literis mihi communicavit amicus, sed an eundem vel à nostro diversum docebit dies."

This description by Brunnich might well apply to a Devil Ray, in which the teeth had been overlooked. The longer upper jaw shows that it is a *Mobula* rather than a *Manta*. Jordan and Fowler (Proc. U.S. Nat. Mus., xxvi., 1903, 665) use the genus *Mobula* Rafinesque for Brunnich's species and remark: "The name *Aodon*, accepted for this genus by Jordan and Evermann, was originally based on a shark of the Red Sea, *Aodon massasa*, said to have microscopic, serrated teeth, and very large pectoral fins. It may belong to the *Scyliorhinidae*".

The first genotype-designation for *Aodon* which I have been able to trace is that of Jordan and Evermann in 1896, who picked *massasa*. This makes *Aodon* a doubtful genus of Arabian sharks, so that it may be dismissed from further consideration here.

Since *Aodon* does not affect the choice of a family name for Devil Rays, it is necessary to discover the next named genus. This is *Mobula* Rafinesque (Index ittiol. Sicil., 1810, 48 & 61—*fide* Sherborn), a genus apparently characterized by an inferiorly situated mouth. Lack of literature unfortunately prevents me from checking the references to *Mobula* and its synonyms, so I am obliged to follow modern authors with regard to them. It is, however, established that *Mobula* must form the root of the family name: *Mobulidae*.

Swainson, in 1839, proposed Pterocephalinae as a subfamily for the Devil Rays, and Hill (Intell. Observer, ii., 1862, 174) is said to have proposed the term *Massenoideae*. Jordan and Evermann (Bull. U.S. Bur. Fish., xxiii., 1, 1903 (1905), 50) stated "The family name *Mantidae* must give way to *Mobulidae*, inasmuch as the same name is used for the group of insects typified by the genus *Mantis*". Fowler (Proc. Acad. Nat. Sci. Philad., lxxxvi., 1934, 351) later provided *Ceratopterinae* with *Manta* as the type genus of the subfamily, and called the other subfamily *Mobulinae* (*Cephalopterinae* Fowler, *olim.*). In view of the marked differences in the mouth regions of these two groups, I propose to raise them to family rank, whilst following Fowler's nominations.

The Devil Rays of the world may now be classified into families, sub-families, and genera, as follows, commencing, for convenience's sake, with the large Australian species.

Family CERATOPTERIDAE.

(Mantidae, olim.)

Large Devil Rays with the mouth wide and terminal. Cephalic fins usually directed forward (Garman, Mem. Mus. Comp. Zool., Harvard, xxxvi., 1913, 448).

Two subfamilies:—

Teeth on lower jaw only. *Ceratopterinae*, et incertae sedis, infra.

Teeth on both jaws. *Indomantinae*.

Subfamily CERATOPTERINAE.

Genus DAEMONOMANTA Whitley, 1932.

Daemonomanta Whitley, Rec. Austr. Mus., xviii., 6, April 20, 1932, 327. Orthotype, *Manta alfredi* Stead = *D. alfredi* (Kreffft).

Desmomanta Fowler, Mem. Bern. P. Bish. Mus., xi., 1934, 386. *Errore*.

Differs from *Manta (birostris)* of authors in the shape of the pectoral fins and in dentition, there being over 200 rows of teeth in lower jaw.

DAEMONOMANTA ALFREDI (Kreffft).

(Plate xii. and text-figs., 1-3.)

Deratoptera alfredi Krefft, Illustrated Sydney News, v., July 11, 1868, 3 & 9, woodcut fig. Port Jackson, N.S. Wales. Holotype (No. I.1731) in Australian Museum.

Ceratoptera alfredi Krefft, Industr. Progress N.S. Wales, Rept. Intercolonial Exhib., 1870, Sydney, 1871, 778. *Id.* Hill, Sydney Mail, May 27, 1871, 394 (near Watson's Bay, Sydney). *Id.* Macleay, Proc. Linn. Soc. N.S. Wales, vi., September 12, 1881, 381, and Descr. Cat. Austr. Fish., ii., 1881, 317 (Manly Beach, err. pro. Watson's Bay). *Id.* Tenison-Woods, Fish and Fisher, N.S. Wales, 1882, 99. *Id.* Ramsay, Cat. Exhib. N.S.W. Court, Fisher. Exhib., 1883, 22. *Id.* Ogilby, Cat. Fish. N.S. Wales, 1886, 6. *Id.* Ogilby, Cat. Fish. Austr. Mus., i., Palaeich., 1888, 23.

Dicerobatus sp. Ramsay, Cat. Exhib. N.S.W. Court, Fisher. Exhib., 1883, 22.

Manta alfredi Waite, Mem. N.S.W. Nat. Club, ii., November 7, 1904, 11 (undescribed). *Id.* Stead, Fish. Austr., 1906, 233 and 238. *Id.* McCulloch, Austr. Zool., i., 7, November 27, 1919, 227, pl. xviii., fig. 43a (type); Austr. Zool. Handbook, i., 1922, 13, pl. iii., fig. 43a; Austr. Mus. Mem., v., 1929, 31. *Id.* Whitley, Austr. Mus. Mag., iv., 1931, 284, figs. (Cape Hawke, N.S.W.). *Id.* Fowler, Mem. Bish. Mus., xi., 1934, 386.

"*Diamond Fish*" McCulloch, Sunday News (Sydney), April 22, 1923, 23 (Cape Hawke, N.S.W., 14 feet wide). *Id.* McCulloch, Illustr. Austr. Encycl., i., 1925, 368 (habits in Queensland).

? *Ceratoptera alfredi* Waterhouse, Roviana and English Dict., 1928, 168 (Roviana, Solomon Islands).

"*Sea Devil*" Marshall, Queensland Nat., viii., 1932, 41 (Cowan Cowan, Moreton Bay, Queensland; 13 feet).

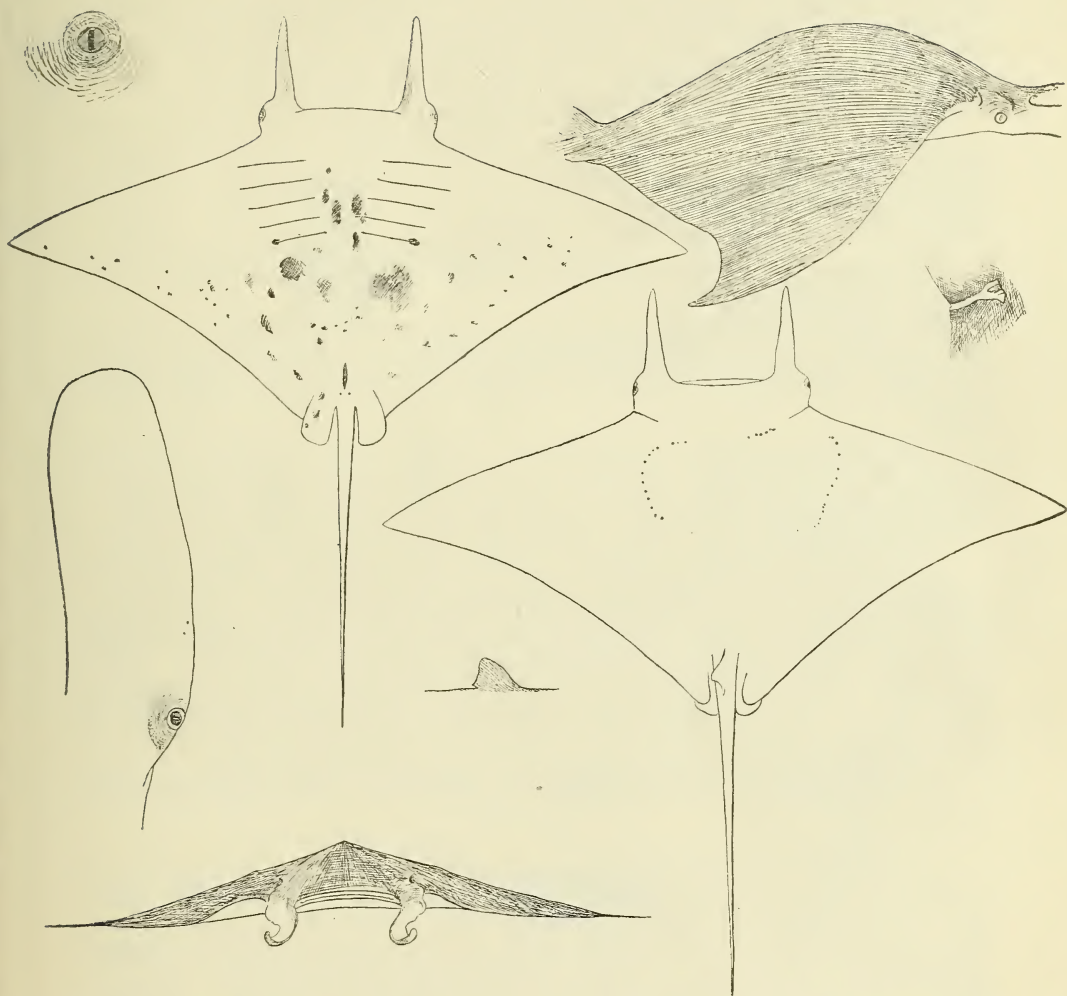
Daemonomanta alfredi Whitley, Rec. Austr. Mus., xviii., 6, April 20, 1932, 328, pl. xxxvii., figs. 1-4 (type figured, also Cape Hawke specimen, and notes ex Ramsay, MS.). *Id.* Barrett, Water Life, 1933, 12, fig. *Id.* Whitley, Austr. Mus. Magazine, vi., 1, "January" = February 21, 1936, 4, and 10 figs. (Maher Is., Cumberland Group, Queensland, and general history of the species).

"Devil Ray" Embury, Sydney Morning Herald, September 29, 1932, photo (Hayman Is., Queensland; about 800 lb.).

Manta Caldwell, Sydney Mail, September 4, 1935 (a disabled Queensland specimen attacked by a shark).

Description of Maher I. Specimen.

Dimensions:—	feet.	inches.
Total length, without tail	4	8
Tail	5	2 $\frac{3}{4}$
Length overall	9	10 $\frac{3}{4}$
Width of disc	11	8
Mouth to base of dorsal fin	4	5 $\frac{1}{2}$
Mouth to pectoral arch, between parallels	2	4
Pectoral arch to vent	2	0
Anterior pectoral margin	5	2 $\frac{1}{2}$
Depth through middle of body, approx.	1	2
Interorbital space	3	0 $\frac{1}{2}$
Maximum diameter of eye	—	0 $\frac{3}{4}$
Dark area around eye	—	3
Eye to mucus pores on cephalic fin	—	4
Width at the "neck"	3	0 $\frac{1}{4}$
Corner of mouth to eye	—	7
Level of mouth to tip of cephalic fin	1	6 $\frac{1}{4}$
Centre of eye to tip of cephalic fin	1	8 $\frac{3}{4}$
Distance between cephalic fins	1	11 $\frac{1}{4}$
Maximum depth of cephalic fin	—	7
Spiracle	—	4 $\frac{1}{2}$
Situation of gill-openings:—		inches.
Level of mouth to first gill-slit		10
Outer corner of first gill-slit to edge of body		3 $\frac{1}{2}$
Outer corner of first gill-slit to that of fifth gill-slit		17 $\frac{1}{2}$
Inner corner of first gill-slit to that of fifth gill-slit		15 $\frac{1}{2}$
Opening of first gill-slit		14
Opening of second gill-slit		15
Opening of third gill-slit		14
Opening of fourth gill-slit		12 $\frac{3}{4}$
Opening of fifth gill-slit		10
Distance between 1st pair of gill-slits		15 $\frac{1}{2}$
Distance between 2nd pair of gill-slits		13 $\frac{1}{2}$
Distance between 3rd pair of gill-slits		11 $\frac{1}{4}$
Distance between 4th pair of gill-slits		9
Distance between 5th pair of gill-slits		7 $\frac{1}{2}$
Distance between 1st and 2nd slits on each side		4 $\frac{1}{2}$
Distance between 2nd and 3rd slits on each side		4 $\frac{1}{4}$
Distance between 3rd and 4th slits on each side		4
Distance between 4th and 5th slits on each side		3 $\frac{1}{2}$
Outer margin of third gill-slit to tip of wing		53 $\frac{1}{2}$
Further dimensions:—		feet. inches.
Lower lip	1	9 $\frac{1}{2}$
Width of mouth	1	10
Band of teeth	1	3
Posterior tip of pectoral to the posterior insertion of that fin	—	7 $\frac{1}{2}$



Text-Figure 1.

Daemomanta alfredi (Krefft) from Maher Island, Queensland. Eye. Ventral view. Partly lateral view. Outline of cephalic fin showing mucus pores before the eye and commencement of shagreen just behind the eye. Lateral view of dorsal fin. Dorsal aspect of whole specimen showing lateral line pores, etc. Spiracle. Anterior aspect of whole specimen.

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Base of dorsal fin	—	8
Height of dorsal fin	—	6
Maximum length of dorsal fin	—	9 $\frac{1}{8}$
Inner length of ventral fin	—	8 $\frac{1}{4}$
Outer length of ventral fin	—	9
Width of ventral fin posteriorly	—	5 $\frac{1}{2}$
Distance between anterior (outer) insertions of ventral fins	—	11
Vent	—	5 $\frac{3}{4}$
Distance between abdominal pores	—	2
Tail, from behind dorsal base	4	8 $\frac{3}{4}$
Width of tail at its ventral base	—	3 $\frac{1}{2}$

Shrinkage was noticeable even a day after death and, of course, continued rapidly thereafter.

The cephalic fins (caropteres, horns, flippers or ears as they are variously called) are the most distinguishing features of Devil Rays. In my specimen, each fin was about one inch thick, but was usually curled when the animal was out of the water. Its shape is shown in an accompanying figure.

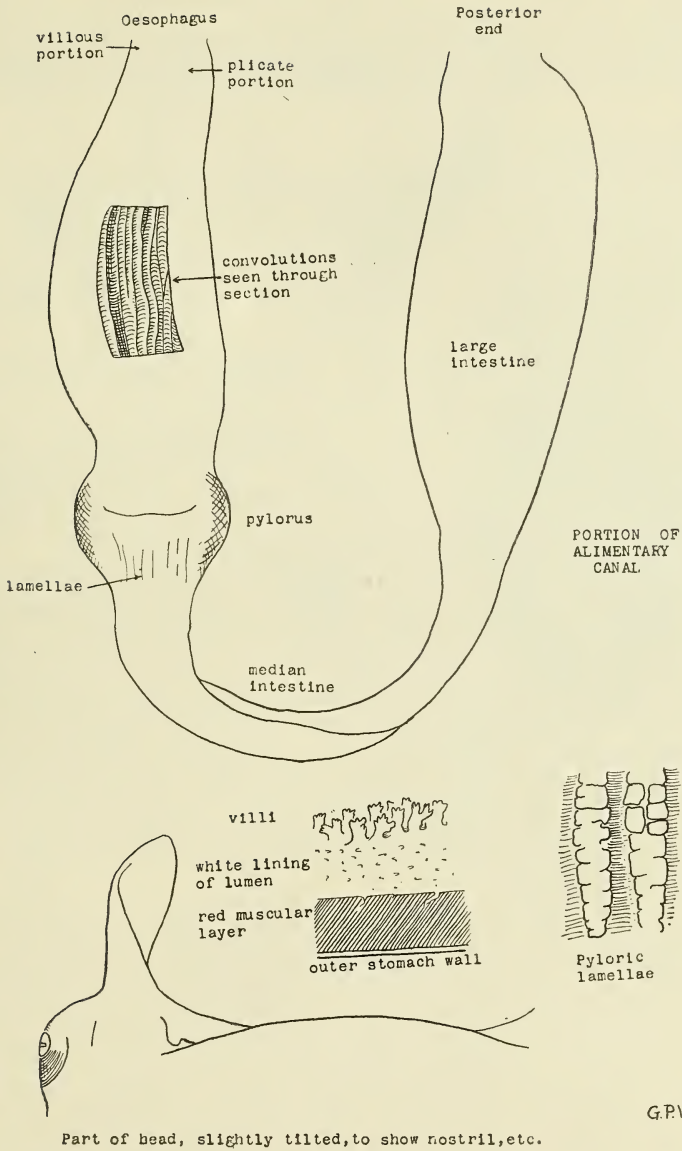
The cephalic fin is supported by a cartilage which I may term the *cephalopterygium*, which is apparently continued from the propterygium. Correlated with this development, which is consequent upon the planktonic feeding habits, are the terminal mouth and widely separated nostrils.

The strong tubercles of shagreen cease behind the eye, which occupies a naked area. There is nothing resembling a nictitating membrane, the margin of the eye being continuous with the surrounding skin. Pupil vertical, slot-shaped. Some distance before the eye are two circular mucus pores, quite inconspicuous. The main mucus-system consists of a series of spaced pores, asymmetrically disposed, across the nape between the spiracles. A row of a dozen or so, along each side of the body outside the propterygium, forms an indistinct "lateral line". Much of the body-surface is studded with smaller pores between the tubercles of the skin.

The spiracles are oblique furrows, connected by a groove with the side of the head.

Dentition:—

At first sight, the jaws appear to be edentulous, but whilst such is the case with the upper jaw, the lower jaw is found to bear teeth which, however, are obviously no longer functional, being covered by a smooth white skin which is joined to the front of the mouth by fibrous tissue. If this connecting tissue be cut, the skin can be rolled back and the teeth exposed. These teeth lie in a strip along the top of the Meckelian cartilage and can be gradually lifted off by means of a scalpel. Near one side, the band of teeth was discontinuous, apparently due to injury or disease. The band of teeth is 380 mm. long and 10 mm. wide at the ends or 16 mm. wide at the middle. The teeth are not in quincunx formation, but are regularly arranged, one behind the other, in numerous rows, seven to nine deep, sometimes with developing teeth behind them. There are 212 of these back-to-front rows, the 80th and 114th from the left-hand side being slightly broader than the others, whilst the 131st and 132nd tend to fuse with their neighbours; the gap, previously mentioned as being probably due to injury or disease, separates the 201st and 202nd tooth-rows. Thus there are, in all, between 1,500 and 2,000 teeth. They are well shown in the



Text-Figure 2.

Daemomanta alfredi (Kreffft) from Maher Island, Queensland. Alimentary canal and parts of its lining (see also Plate xii., fig. 5). Also portion of head, from below.

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photographs published in The Australian Museum Magazine, Vol. vi., No. 1, 1936, 10, fig.

The prebranchial and branchial apparatus formed very beautiful strap-gills and strainners, such as have been recently described by Delsman and Hardenberg (De Indische Zeevisschen en Zeevisscherij, Batavia, 1934, 109 and fig.).

General characters:—

Broadly diamond-shaped, without a ridge along the back and having the general features shown in the figures. Lower jaw the longer.

Body covered with rough shagreen, which becomes coarsest on the upper surface of the tail, and fairly rough on the back towards ventral fins and tail. No enlarged denticles along middle of back. Tubercles almost everywhere except on eyes, in spiracles, in mouth, and on lips.

Dorsal fin well developed. No anal fin.

Tail elongate, rough; there is a low ridge along the upper and lower surface, but no fin-fold nor any spine or bony boss (Plate xii., figs. 1 & 2).

Abdominal pores nearer to vent than to base of tail.

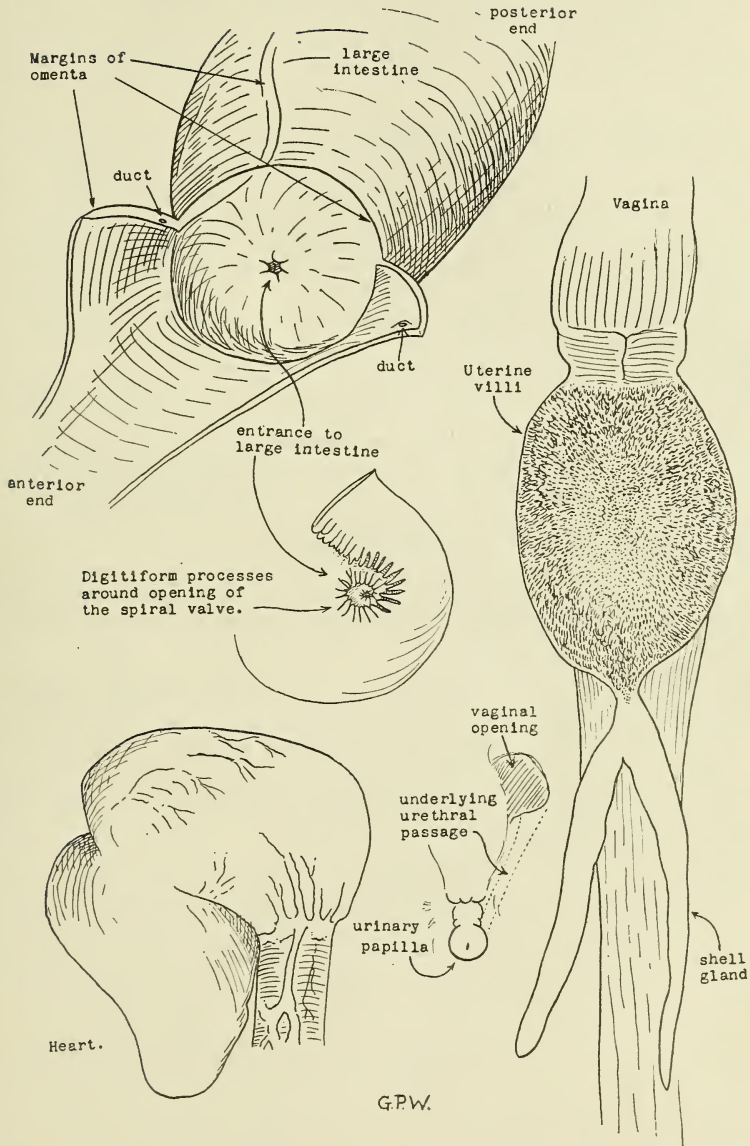
Colour.—Upper surface very dark slate grey, tinged in parts with bluish, though the blue is subdued by the darker grey. Towards the upper lip the grey turns to powder blue and gradates to white on the upper lip itself, the powder blue tinge being continued laterally on to each cephalic fin. Nostrils and interior of spiracles white. The well-developed dorsal fin is dark grey, like the disc. Upper surface of tail also dark grey.

Ventral surface white, with large irregular and asymmetrical steel blue blotches on chest and belly, some extending to hinder parts of pectoral fin and on the right (but not the left) ventral. Under surface of the tail white, except towards the end, where it is blue or very dark grey, almost black. There is a very narrow fringe of dark blue near tips of pectoral fins.

Outer surfaces of cephalic fins white, inner surface dusted with dark powder blue. Iris very dark bluish grey. Pupil dark-brown with a black vertical slit centrally. Below the eye is a suffused powder blue area.

Alimentary canal.—The stomach and intestine, with the omenta removed, are shown in the accompanying figure, which may be compared with the illustrations to Mazza's paper on the corresponding structures of *Cephaloptera giornae* (Ann. Mus. Civ. Storia Nat. Genova (2), x., 1891, 519-536, 2 pls.), as follows:—

In the Queensland Devil Ray, the anterior portion of the lumen of the oesophagus is lined with numerous villi (*papille faringee* of Mazza), seven millimetres or so high. Some of the villi are much branched, others papilliform, and they are soon replaced by a transversely plicated portion (*mucosa esofagea pieghettata in senso trasversale*) leading directly, where Mazza shows a *cingolo gastroesofageo*, into the soft, liver-brown or reddish, spongy interior of the stomach whose walls are thrown up into long convolutions (*Pieghe longitudinali della mucosa (regione cardiaca dello stomaco) colle scissure trasverse*). Just before the pylorus, the muscular walls of the alimentary canal are much thickened and there is a pronounced bulge on each side (*Rilievi delle pareti dello stomaco (porzione pilorica) formanti le valvole a colonna*). Between the lateral bulges, the walls of the lumen resume their papilliform nature and, towards the pylorus, are elevated as longitudinal lamellae with their crests thrown up into folds rather recalling the crowns of molars (text-fig. 2). There are nineteen small lamellae and nineteen large ones, though some bifurcate posteriorly. Immediately behind these comes the narrow post-pyloric lumen,



Text-Figure 3.

Daemomanta alfredi (Krefft) from Maher Island, Queensland. Entrance to large intestine, urino-genital organs, and heart.

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which Mazza calls the *Intestino medio (prima porzione)*, and which is without any papillae, processes, villi, or lamellae whatever, and this leads into the bag-like large intestine. See plate xii., fig. 5 and text-figure 3.

The appearance of the entrance into the large intestine is shown in the opposite sketch (text-fig. 3). A duct has been cut through, just before the origin of the large intestine. The entrance is small and the spiral turns of the valve commence immediately, their inner edges being thrown into digitiform processes. There are forty-four turns of the spiral valve before the rectum (*dilatazione cloacale*) is reached. The outermost wall of the large intestine is white and tough like gristle, but the pinkish walls of the spiral valve are soft and increase in height backward until some of them are over three inches high. The digitiform processes at the commencement of the spiral valve become more spaced and lobe-like further back, the most posterior being reddish. Some parts of the spiral valve are encrusted with white matter as if food had solidified over slightly inflamed areas. No internal parasites were observed.

Food.—The stomach contained only a dirty reddish-yellow fluid, and the contents of the spiral valve of the intestine were a syrupy dirty yellow liquid. In this are remains of minute crustacea, probably copepoda.

Parasites.—Some Cymothoid crustacea, the *Praniza*-larvae of *Gnathia* sp., were found in the branchial cavities, but otherwise there were no parasites on the body, in the alimentary canal or on gills. Neither was the Devil Ray attended by Pilot or Sucker Fishes.

Internal anatomy.—The heart was a large purplish-red organ, $7\frac{1}{4}$ by $5\frac{1}{2}$ inches, lying just before the pectoral arch. There were some blackish marks near the dorsum, where the specimen might have been harpooned or otherwise injured previously.

Some partially formed ova, about 10 to 12 mm. in diameter, in the Graafian follicles. Near the rectum was a bag-like structure with very muscular walls and a dendritic formation interiorly. No embryos could be found. Both uteri are functional and above them are the many-lobed kidneys. The uterine villi were dull reddish and the shell-gland pale yellow. At the neck of the uterus is a constricted area with transverse muscles, followed by a longitudinally plicate lumen leading to the vagina. A rounded urinary papilla (text-figure 3).

The skull and brain are unfortunately damaged by the harpoon, but the top of the skull is $1\frac{1}{4}$ inches thick and the cranial cavity is approximately 5 inches wide, with extensive prolongations to the nostrils, and tapering at its posterior end. The nostril flaps are broad. There is a broad *velum maxillare* in the mouth. This organ, which has recently been treated with by Gudger (Journal of Morphology, lvii., 1935, 91 and figs.) is apparently the *Gaumensegel* of Müller and Henle (Ber. Verh. K. Pr. Akad. Wiss., Berlin, 1837, 111), the *Soupape* of Bosc (Nouv. Dict. Hist. Nat., xix., 1803, 170), and the velum, maxillary breathing valve, frenum, or buccal flap of English authors. This structure is common to many elasmobranchs and fishes, and is strikingly shown in Greene's figure of the Toadfish *Porichthys* reproduced by Jacobs (Natur und Volk, lxx., 1935, 161 and fig.).

The minute food of the Devil Ray is apparently swallowed whole, regurgitation and straining through the gills being prevented by the velum maxillare and the loofah-like prebranchial apparatus.

Native name, in the language of the Whitsunday Passage aborigines, *Mungoona*.

Described and figured from a specimen, 11 feet 8 inches across the

pectoral fins, from Maher Island, Cumberland Group, Queensland; July 20, 1935. Pieces of skin, tail, teeth, stomach-contents, etc., preserved in The Australian Museum, where they are registered No. IA.6550.

The following account of its capture is taken from The Australian Museum Magazine:—

"Saturday, July 20, 1935, was a fine, sunny, winter day, with a calm, sparkling sea between Lindeman and Maher Island, our destination. Here Devil Rays were known to congregate at this time of the year until about November, and several were seen cruising in the vicinity of the inshore reefs. They swam rather slowly, apparently undulating the body, and with their mouths open and the cephalic fins ("ears", "horns", caropteres, or flippers) extended on either side; often one would break the surface, or they curled one or both tips of the wing-like pectoral fins right out of the water. At other times they swam well below the surface or perhaps even sank to the bottom (especially when we wanted to get near them). The launch anchored, I embarked in a small dinghy with Messrs. Melbourne Ward, Loch Nicolson, and Dick Lahou, a Torres Strait islander. After a while, a fine Devil Ray was seen approaching the bows of the dinghy, where Dick stood with harpoon poised and rope coiled ready; he also had a knife within reach to cut us loose in case of danger. Soon we were nearly on top of the monster and, with a powerful plunge, Dick rammed the barb into the creature's skull. To our surprise, the victim did not run away with the boat, as we had expected, neither did it flap or struggle; it simply subsided in the water and died. Dick was greatly excited; he had speared many turtles and dugong, but this was his first Devil Ray. "I kill him. I bin *kill* him", he yelled, and then we set to work to prevent the prize from sinking. Its head was pulled to the surface, when it was found that the steel harpoon had bent under the great weight; a rope was passed through a hole cut in one cephalic fin, and the trophy borne in triumph to a beach nearby. Blood crimsoned the water for many yards around, and we tugged the ray ashore as quickly as possible for fear of sharks. After taking photographs, I removed the stomach and intestines as I was anxious to ascertain the food of such a monster (it was over 11½ feet wide). Only a little syrupy pulp was found in the alimentary canal, however, and this contained the remains of minute crustacea. So, like some whales, the giant Devil Ray must feed on the smallest floating creatures, the plankton.

The launch towed the ray back to Lindeman Island, where I was able to measure and sketch, photograph and dissect the specimen confirming in all detail its identification as a Prince Alfred's Ray. The specimen was so heavy that it was necessary to wait for the tide to help lift it at high water. No sharks were seen anywhere in the vicinity of the dead ray, but sea-eagles and gulls kept a watchful eye on my activities. I threw some scraps to them, and those eagles were as attracted to pieces of liver as if they had been torn from Prometheus himself."

After the capture of the Maher Island Devil Ray, I occasionally saw others. On an August afternoon, in a mainland bay near Saddleback Island, I noticed a large black fin rise from the water near a submerged coral reef, to be followed immediately by a white fin. At first, I took them to be those of the black and white "porpoises" of the Bowen district, but saw through the ship's telescope that they were joined by a large black body. A better view showed that the fins were the tips of a Devil Ray's pectorals, and I watched the animal systematically cruising along the reef, and sketched it off the western shore of the bay. . . . It would not venture

over the reef into the shallows over the sand flats. . . . Presently another ray joined it and they cruised in company, one behind the other, then, in less than one hour, both had gone out to sea.

Another specimen seen in Gloucester Passage, a few miles away from the above locality.

Now that game fishermen are paying more attention to our tropical waters, it is probable that more specimens of these giant rays may be caught. We have certainly much to learn concerning them. The male has yet to be described; an embryo specimen is much to be desired; and the structure of the brain and nervous system would repay study. These rays are apparently harmless creatures, though they sometimes fall foul of ropes or anchor-chains, but it is extremely doubtful whether they would attack man, notwithstanding the fearsome reports of ancient writers. I would, however, plead that they be not senselessly slaughtered, for they are unique animals and probably breed slowly. They are apparently the product of a very ancient line of evolution, as, although they outwardly resemble Eagle Rays and other stingrays, but for the "horns", the terminal mouth, and other characters modified in accordance with their mode of existence, they are really not very closely related to those commoner creatures, as their skeletons and internal structure show. Once reduced in numbers by unsportsmanlike anglers, these curious animals might well become extinct, instead of continuing to enjoy themselves harmlessly and afford amusement to sightseers in the future.

History of the Australian Devil Ray or Prince Alfred's Ray.—In view of the fact that local workers have confused the type-locality and other details concerning the Australian species, *Daemomanta alfredi*, it seems worth while to recapitulate the history of the species from the year 1868, when it was first discovered.

Here is the first notice of the Australian Devil Ray, taken from the "Sydney Morning Herald" of Tuesday, 31 March, 1868, page 4, column 2:—

Curious Fish.—On Sunday morning, at 11 o'clock, a curious fish was caught near the old pier at Watson's Bay, being harpooned by a man named Wallace. It measures 14 feet 6 inches across, 20 inches through the thickest part. It very much resembles a tortoise, only on the back portion of the body it has two tails, one running out flat, and the other like a whip through. Its mouth measures 2 feet 6 inches from side to side, and when open it is about 9 inches all along. The liver weighs about one hundredweight, and when boiled it is expected it will yield about seven gallons of oil. There are two large flappers on each side of the mouth by which it forces its food in, and there are ten strainers on the belly, five on each side. We understand the name of this strange-looking animal is the devilfish.

On searching through newspaper files in the Mitchell Library, Sydney, I found, in the "Illustrated Sydney News" of July 11, 1868, p. 3, and fig., the first picture of the Devil Ray, which was reproduced, by courtesy of the Librarian, in The Australian Museum Magazine, with the following description, anonymous, but evidently by Gerard Krefft, then Curator of The Australian Museum:—

DERATOPTERA ALFREDI (Prince Alfred's Ray).

It was a "royal fish" indeed those bold fellows battled with not long ago at Watson's Bay, and the "fool at one end and the worm at the other" could never have caught such a monster. Downright hard work, harpooning and hauling, secured the prize, which fetched a considerable number

of sixpences from the curious, and a five pound note from the Museum Trustees, who did well to secure this fine specimen. Few persons know the labour of successfully preserving so large a fish, and they will perhaps scarcely credit it, that it took Mr. Tost, the able taxidermist, fully three weeks to finish it. It is now exhibited (free of charge, of course) in the Museum, College Street. The fish is some fourteen feet broad, and, including the tail, about eight long. He, or rather she (it is a female), has gills like a shark, and a curious pair of head-fins on each side, which are used for the purpose of feeding; in fact, the fishermen state that the fish shovels the prawns and other cray-fish down its capacious throat with these fins, which look exactly like a pair of gigantic ears. The mouth is very large, and, without exaggeration, reaches from "ear to ear". The teeth are very small, so diminutive that they can only be detected by close examination. Coloration—bluish above, white, with some darker markings, below. The Sea Devil is quite a harmless kind of fish, though of great strength, and wonderful tales are current of the pranks this playful giant frequently plays. De Kay, in his natural history of New York, mentions that one of them had hold of the cable of a good-sized schooner, and towed it forwards and backwards through the harbour for some time. The present specimen is the largest fish of this kind which has ever been preserved, and it is well worth a visit to the Museum to inspect it. The specific name of *Alfredi* was given to it, with the permission, and in honour of, His Royal Highness the Duke of Edinburgh, who accepted a number of photographs taken shortly after the fish was caught. The photographs are by Mr. Henry Barnes of the Museum.

Hill, in a series of articles on fish and fishing in New South Wales, wrote as follows regarding our species ("Sydney Mail", May 27, 1871, 394):—

"The devil-fish (as it is called) is of the family *Myliobatidae*, and of the genus *Ceratoptera Alfredi*. The disc is very broad, in consequence of the great development of the pectoral fins, which, however, leave the sides of the head free, and at the sides of the mouth is a pair of detached fins. This fish was caught in the vicinity of Watson's Bay, some months ago, and is now deposited in the Sydney Museum, and which affords a fine specimen of the family *Raia*—measuring across the wings or fins not less than fifteen feet, and must have weighed something more than even the famous ones recorded by Cook."

Hill says the specimen was caught "some months ago", but so far I can trace it it was about three years before, but perhaps publication of his manuscript may have been delayed. The rays caught by Captain Cook's men were *Dasyatidae* rather than Devil Rays.

All the preceding accounts refer to Krefft's type, which is still in the Museum, the width of which has been variously given as 11 feet, 12 feet 9 inches, 13½ feet and 15 feet! The type-locality is now established as Watson's Bay, at the entrance of Sydney Harbour, not Manly, as stated by Macleay, and the year of capture was 1868, not about 1870, as suggested by Hill, nor 1874 as stated by Tenison-Woods.

I have been unable to find any mention of Devil Rays in the old Annual Reports of the Australian Museum, in the Illustrated Sydney News prior to June, 1868, in books and cuttings relating to Prince Alfred's visit to Australia in the "*Galatea*" in 1868, nor in the eight volumes of Krefft's MSS. and papers in the Mitchell Library, Sydney.

A small example, 4½ feet wide (Austr. Mus., regd. No. I.1732, but now

missing), was recorded from Middle Harbour, near Sydney, by Ogilby, in 1886, and the late E. P. Ramsay made sketches of a local specimen, perhaps this very one, whilst photos of it are bound in Austr. Mus. photo. album Fishes, p. 69. The species is apparently rare in New South Wales, no further specimen having been noticed until 1923, when Mr. G. E. Tanner, of the Amateur Fishermen's Association, caught one off Cape Hawke. This was figured in The Australian Museum Magazine, iv., 1931, 284, fig., and in the paper wherein *Daemomanta* was first named. The specimen was not, however, preserved. Mr. Henry Grant, Chief Taxidermist of The Australian Museum, informs me that he saw a Devil Ray caught at Shell-harbour some years ago; this is the southernmost record.

Evidently, it is a tropical species, which only occasionally drifts so far south. McCulloch, in the *Illustrated Australian Encyclopaedia*, wrote that these fish are not uncommon on the coast of Queensland (he had seen some near the reefs off Cairns some years previously), and T. C. Marshall, in the *Queensland Naturalist*, 1932, noted a Sea Devil, 13 feet wide, which had been stranded at Cowan Cowan, Moreton Bay. These were all the Queensland records known to me until reports came from tourists accompanying the Embury Bros. parties to North Queensland that Devil Rays could be caught at Hayman Island, and pictures of the monsters appeared in the press* and in angling papers. I implored game fishermen to try to secure measurements, teeth, relics of any kind, but was generally informed that the rays sank to the bottom when killed, and were usually too heavy to remove from the water, even to photograph. Finally, in 1935, the specimen described above was secured and the first published record, in any detail, of a Devil Ray from Queensland was published in The Australian Museum Magazine. There are, it is true, Horned Rays or Diamond-fish figured in Saville-Kent's book on *The Great Barrier Reef*, but they belong to a very different smaller species, *Mobula diabolus* (Shaw), which has the mouth situated well below the head, not at the end of it as in the giant Devil Ray, and this kind is dealt with later on in the present thesis.

Having dealt with the Australian Devil Ray in, I hope, sufficient detail to enable the next person who catches one to make further notes for comparison, I propose to list, briefly, the synonymy of the remaining nominal species of Devil Rays in the world.

Genus MANTA Bancroft, 1829.

Manta Bancroft, Zool. Journ. (Vigors), iv., May, 1829, 454. Haplotype, *Manta americana* Bancroft = *M. birostris* of authors. Not *Mantis* Linné, Syst. Nat., ed. 12, 1767, 689, a genus of orthopterous insects, derived from *mantis*, a soothsayer, whereas Bancroft's name is from *manta*, a blanket.

Ceratoptera Müller and Henle, Ber. Verh. K. pr. Akad. Wiss., 1837, 118 (here based solely on Lesueur's "*Cephaloptera*") and Plagiost., iii., 1841, 186. Haplotype, *Ceratoptera lesueurii* Swainson = *Manta birostris*, as here restricted.

Brachioptilon Newman, Zoologist, vii., 1849, 2358. Haplotype, *B. hamiltoni* Newman.

*In the Sydney Morning Herald, September 29, 1932, is a fine photograph of a Devil Ray with the caption "Weighing 800 lb., this huge Devil Ray was harpooned recently by the advance party of the ninth Embury Scientific Expedition, domiciled on Hayman Island, Whitsunday Passage, Queensland". See also the Daily Telegraph (Sydney), September 11, 1934, for a fine photo. of another Hayman Island specimen.

Diabolichthys Holmes, Proc. Elliott Soc. Nat. Hist., i., 1856, 39. Orthotype, *D. elliotti* Holmes—*vide* Jordan, Gen. Fish., ii., 1919, 270.

The genus *Manta* is here used to include a number of species which may prove, with better acquaintance, to be divisible into more than one genus. The Australian form is not congeneric with the typical *Manta birostris*, and the Red Sea *Manta ehrenbergii* may be another species of *Daemomanta*. It is possible that some new generic names may yet have to be proposed for some of the species.

MANTA BIROSTRIS (Donndorff).

"*Divel-Fish*" Catesby, Nat. Hist. Carolina, 1731, 32, Carolina. Not seen.

"*Raja birostris*, etc.," Walbaum, Artedi Ichth. (3), ed. 2, 1792, 535. Non-binomial. Type-locality, Carolina, selected by Fowler, Mem. Bish. Mus., x., 1928.

Raja birostris Donndorff, Zool. Beytr., iii., 1798, 876. [Carolina.]

"*Raje-Diable*" Gallus, Tableau de Cayenne où de la Guiane française, Paris, 1799, 132. Not seen.

Raia fimbriata Lacépède, Hist. Nat. Poiss., iv., 1802, 671 and 677, pl. xvi., fig. 3. North Atlantic Ocean.

Cephalopterus vampyrus Mitchill, Ann. Lyc. Nat. Hist. N. York, i., 1824, 23, pl. ii., fig. 1. Delaware Bay, U.S.A. Perhaps published in 1823.

Cephaloptera giorna Le Sueur, Journ. Acad. Nat. Sci. Philad., iv., 1824, 115, pl. vi. Delaware. Not *Raia giorna* Lacépède.

Raia cornuta Le Sueur, Journ. Acad. Nat. Sci. Philad., iv., 1824, 120. Azore Islands, etc. Published November, 1824, thus later than Mitchill.

Cephalopterus manta Bancroft, Zool. Journ., iv., 1829, 453. Jamaica. *Id.* Bancroft, Proc. Comm. Sci. Zool. Soc., 1830, 134.

Manta americana Bancroft, Zool. Journ., iv., 1829, 454. Jamaica.

Cephalopterus giorna Hunter, Cat. Roy. Coll. Surg., ii., 1834, 38 and 84, *et ibid.*, iii., 1836, 148, *et ibid.*, iv., 1838, 51. Not *Raia giorna* Lacépède.

Ceratoptera lesueurii Swainson, Nat. Hist. Classif. Fish. Amphib. Rept., ii., July, 1839, 320, fig. 100. *Ex* Le Sueur, 1824. Delaware.

Cephaloptera diabolus Valenciennes, Règne Anim. (Cuvier), Disciples' edition, 1839, pl. cxix. *Ex* Mitchill. America.

Ceratoptera johnii Müller and Henle, Plagiost. (3), 1841, 186, pl. lix. Jamaica.

Cephaloptera vampirus Dekay, Faun. N. York, 1842, Pisces, 377, pl. lxxvii., fig. 219.

? *Brachioptilon hamiltoni* Newman, Zoologist, vii., 1849, 2358. West coast of Mexico; *vide infra*.

Diabolichthys elliotti Holmes, Proc. Elliott Soc. Nat. Hist., i., 1856, 39. Charleston, South Carolina, U.S.A.

Ceratoptera vampirus Duméril, Hist. Nat. Poiss., i., 2, Elasm., 1865, 660.

Ceratoptera vampyrus Gunther, Cat. Fish. Brit. Mus., viii., 1870, 498.

Manta birostris Jordan and Gilbert, Bull. U.S. Nat. Mus., iii., 16; Smithsonian Misc. Coll., xxiv., 1882, 52; and of most modern authors.

? *Manta raya* Baer, Bull. Mus. Hist. Nat. Paris, v., 1899, 112. Zorritos, Peru.

Manta brevirostra Holder, Big Game at Sea, 1908, 17, figs. 1-4. *Ex* "Outing" Magazine, 1900. Florida reef. *Errore pro M. birostris*.

Manta vampyrus Gill, Smithsonian Misc. Coll., lii., 2, 1908, 155-180. "The Story of the Devil Fish"—an excellent resumé.

Manta birostris Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi., 1913, 454. *Id.* Hubbs, Copeia, 37, 1916, 87 (Los Angeles county ?). *Id.* Coles, Amer. Mus. Journ., xvi., 4, 1916, 217, figs. (Florida—capture and casting

of large specimen). *Id.* Gudger, Science, lv., 1922, 338 (Block I—most northerly rec. in U.S.A.). *Id.* Townsend Bull. N.Y. Zool., Soc., xxii., 6, 1919, 140, fig. (Bahamas—22 feet wide). *Id.* Walford, Calif. Fish and Game, xvii., 4, 1931, 404, fig. (San Pedro, Cal.).

The American Devil Fish, usually called *Manta birostris*, following Jordan and Gilbert, is the one most figured in natural history books and encyclopaedias. The specific name should be credited to Donndorff, since Walbaum's original account is non-binomial:—

"*Raja, birostris, rostro bifido; corpore cruciformi pinnis pectoralibus praelongis, attenuatis, W.*

Diabolus marinus Willughby App., p. 5, tab. 9, fig. 3.

Cutis versus caput fuscis lituris pingitur. Longitudino 7 pedum et ultra.

The Diver-Ray. Pennant arct. Zool., suppl. 104.

The Diver-Fish. Catesby, App., xxxii."

Donndorff's account is similar to Walbaum's but binomial.

Garman's next synonym is *Raia manatia*, but Lacépède distinctly mentioned the inferior mouth in his description, so that this is a *Mobula*, not a *Manta*, and will be considered later, under the family *Mobulidae*.

The *Raja banksiana* of Lacépède is evidently a Devil Ray of the *Manta* kind from the East (or West ?) Indies, and has the advantage of a proper binomial name. However, I propose to employ Lacépède's name for the East Indian representative of *Manta birostris*. Perhaps the eastern American Devil Ray might be better known as *Manta fimbriata* (Lacépède), Walbaum's description being mainly based on the "Indies" specimen.

Dean's *Bibliography of Fishes* gives numerous references to Devil Rays, and I have consulted every one of these which is available in Sydney, but there are many papers not accessible to me.

Raia cornuta Le Sueur, 1824, and *Manta raya* Baer, 1899, appear to be hitherto unrecorded synonyms of *Manta birostris*, auct.

MANTA HAMILTONI (Newman).

Brachioptilon hamiltoni Newman, Zoologist, vii., 1849, 74. Gulf of California, west coast of Mexico.

Manta hamiltoni Beebe, The Arcturus Adventure, 1926, 123, 134, 206 and 304, 415, figs. 30 and 35. Galapagos; 18 ft. specimen, weighed 2,310 lb.

Manta sp., Pinchot, To the South Seas, 1930, 66 (only). Cocos Island, between Galapagos and Central America.

Manta hamiltoni Jordan, Evermann, and Clark, Rept. U.S. Comm. Fish., 1928, ii. (1930), 32.

This species is regarded as the Pacific American form of *Manta birostris*, whose range is given as from "San Diego; Gulf of California to Panama" and Pinchot's Cocos Is. *Manta* is probably conspecific.

MANTA ? BANKSIANA (Lacépède).

Raja banksiana Lacépède, Hist. Nat. Poiss., ii., 1800, 105, pl. v., fig. 3. East Indies (Fabroni). Based on the Sea Devil of Nieuhoff, Gedenkwaerdige Zee en Lantreize, 1682, 275 and fig. *Id.* Shaw, Gen. Zool., v., 2, 1804, 292, pl. cxlv. East Indies (drawing sent to Banks) and Barbadoes. Modified figure after Nieuhoff, Willughby, and Lacépède.

Dicerobatus banksianus Blainville, Bull. Sci. Soc. Philom. Paris, August, 1816, 121. *Ex* Lacépède—*teste* Sherborn.

Cephalopterus banksianus Cloquet, Dict. Sci. Nat., vii., 1817, 409.

Dicerobatis eregoodoo Wood-Jones, Coral and Atolls, 1910, 321, 323 and 347, fig. 74. Cocos-Keeling Atoll. Not *D. eregoodoo* Cantor, 1850.

The large Devil Ray of the East Indies has not yet been satisfactorily described, although recorded from there for many years. The earliest illustration I have seen is that of Johan Nieuhoff's Gedenkwaardige Zee en Lantreize, 1682, wherein a specimen, evidently from the East rather than the West Indies, is described as follows:—

"Zee-duivel. Wel te recht wort dit Slagh van visschen een *zeeduivel*, van wegen zijne ijsselijke en vervareljke gedaente, by d'onzen genoemt. D'oogen staen aen d'eene zyde, en de bek in de holligheit, voor by de kop. Sy hebben een roggen steert, en aen ieder zyde twee lange lellen, die allengs spits toe-loopen. De hui is voor aen de kop vol bruine stipjes, en het lijf op zommige plaetsen doorkerft. Eenigen zijn heel groot, en wel zeven of acht voeten lang. Het is mede een geslaght van roggen; maer sterk en gros van visch, en zwaer om te verteeren."

Nieuhoff's figure was copied by later authors, sometimes with tendrils issuing from the cephalic fins to catch fish. Perhaps the early artists confused the "Zeeuivel" with the Squid, also known as Devil Fish, an animal which has two extra long arms for catching its prey.

Wood-Jones, speaking of the fishes of Cocos-Keeling, remarks:—

"The largest of all the atoll fish is the *Ikqn pareh*, or "devil-fish" (*Dicerobatis eregoodoo*), and it is to a certain extent a useful fish, for a quantity of oil can be prepared from its liver, and its skin makes excellent sand-paper. The Pareh is the royal game of the islands, and the spearing of one which measured 13 feet across was the most exciting fishing expedition that I have been privileged to take part in. The Pareh is a curious fish, which comes to the lagoon only at certain times of the year, and generally on a rising evening tide. At such times I have seen as many as twenty in the sail between Pulu Tikus and Pulu Selma; but for long periods not one will be seen anywhere in the neighbourhood of these islands."

Wood-Jones' illustration shows a Devil Ray with terminal mouth, a species of *Manta*, possibly *banksiana*, and not an "Eregoodoo". He states (loc. cit. 321) that the body of the speared Devil Fish was attacked by sharks.

Mr. F. H. Davies writes from Nauru Island, Central Pacific (*in. lit.* 18 November, 1935; Austr. Mus. file, 537/35), as follows:—

"Recently I came across the carcase of a *Manta birostris* or more commonly known as the Devil Fish or Sea Devil, washed up on the reef on this island. It measured 8 feet 6 inches from tip to tip of the pectoral fins. For curiosity's sake I cut it open, and I discovered a distinct uterus containing a fully developed young, which I preserved as a proof of my statement as the majority of the people of this island flout the idea that the Devil Fish is a mammal."

I have not yet seen Mr. Davies' specimen, but it may be a *Manta banksiana*, so too may be the Devil Ray from the Solomon Islands mentioned in Waterhouse's Roviana and English Dictionary.

MANTA ORISSA (Lloyd).

Ceratoptera orissa Lloyd, Rec. Ind. Mus., ii., 2, July, 1908, 176, pl. v., figs. 1-3; pl. x., figs. 1 and 2 (skull), and text-figure 1. Puri, Orissa coast, India. *Id.* Annandale, Mem. Ind. Mus., ii., 1909, 4.

A Bay of Bengal species, sometimes united by authors with *ehrenbergii* from the Red Sea. Lloyd's specimen was very incomplete, but he gave some important anatomical details and demonstrated the ordinal distinction between the Devil Rays and Eagle Rays (*Myliobatidae*) which had been regarded as related families.

MANTA PINCHOTI, sp. nov.

Manta birostris Fowler, Proc. U.S. Nat. Mus., lxxx., 6, 1932, 2. Marquesas Islands. Not "*Manta birostris* Walbaum". Part referring to the Marquesas "Sea Bat" of Pinchot, To the South Seas, 1930, 405, et seq., and 480, plate opp. p. 410 and figs. on 417-419, also coloured cover.

A White-shouldered Devil Ray, distinguished by its conspicuous markings, as figured by Pinchot. These shoulder marks do not, however, unite to form a chevron.

Total length, including cephalic fin and tail, fourteen feet, two inches. Breadth of disc, eighteen feet, five inches.

Locality.—Near Hat Island (Teuaua), Ua Huka, Marquesas Islands (Pinchot). The Marquesan vernacular for this species was *Ipuohotea*, but their *Toake* is probably also this species.

Fowler (*loc. cit.*, 1932) mentions, from Pinchot's expedition, the "Jaws of a large example as a dry preparation, without exact data. Upper edentulous jaw 920 mm. wide. Lower jaw 1,200 mm. wide, dentary area 610 mm. as measured over surface. Teeth estimated in 416 transverse rows, in which there are 7 to 10 short truncate or obtuse small teeth, the crown of each from nearly level to convex".

It is a pity that the locality was not noted, as the large number of teeth in the lower jaw is noteworthy. Possibly (deducing from Pinchot's writings), this was a large Marquesan example, and it may not be a true *Manta*, but rather a new genus. In the absence of better evidence, however, I only tentatively regard this description as applying to *Manta pinchoti*.

The new species is named in honour of Governor Gifford Pinchot, author of "To the South Seas", and collector of several very interesting Pacific Devil Rays.

MANTA FOWLERI, sp. nov.

Manta birostris Fowler, Bull. Bernice P. Bishop Mus., xxxviii., 1927, 3, pl. i., figs. D-G. Fanning Island, Oceania. Not "*Manta birostris*", etc., Walbaum, 1792, from Carolina.

Fowler's figures are quite unlike any other Devil Ray known to me, and I have much pleasure in associating his name with what is evidently a new species. The chevron-marks on the back rather recall those of certain Eagle Rays, figured in Russell's "Fishes of Vizagapatam" and Shaw's "General Zoology".

The squat diamond shape of the body and the narrow gill-slits appear to differentiate this species further.

Fowler's description reads:—

"Disk nearly twice as wide as long; tail broken terminally so now less than disk length. Pectorals rather narrowly triangular terminally, front edge slightly convex, hind edge concave. No upper teeth; lower (in 139 rows in lower jaw) estimated about 280 in entire series lateral are about $\frac{3}{4}$ extent of lower jaw width. Body and tail rough with small tubercles; external thoracic region very rough, with enlarged, scattered, small buck-

lers, rasping to touch. Dorsal base extends slightly before front ends of pectoral bases. Ventrals small, obtuse, extend little beyond hind ends of pectorals and claspers still further. No caudal spine.

"Back blue-black, with two V-shaped ashy bands, angles forming at vertebral line and pointed backward. Eyes black. White ventrally, with bluish wash along hind edges of fins. Deep blue spots scattered on belly and lower posterior surfaces of pectorals."

Fanning Island. Width of head about 700 mm. Cephalic fin 300 mm. Fowler remarked: "The specimen . . . differs from any I can find in its coloration, possibly also a condition of youth. For the present I include all the nominal forms under *Manta birostris*".

MANTA PAKOKA, sp. nov.

Under the Polynesian vernacular name *Pakoka*, Pinchot (To the South Seas, 1930, 406, 408 and 421 and fig.) described what is apparently a new species of Devil Ray. He says:—

"This *Manta* was far swifter and more aggressive than the white-spotted one [*Manta pinchoti*, mihi—G.P.W.]. Wings black underneath. Total breadth across the back, seventeen feet six inches. Total length, fore and aft, ten feet eight inches."

Locality.—Near Hat Island (Teuaua), Ua Huka, Marquesas Islands (Pinchot Expedition).

The size of the specimen indicates that it is not the young of some described species, and the black ventral surface is a unique feature.

*MANTA EHRENBERGII (Müller and Henle).

Ceratoptera ehrenbergii Müller and Henle, Plagiost (3), 1841, 187. Red Sea. And of later authors.

Cephaloptera stelligera Günther, Cat. Fish. Brit. Mus., viii., 1870, 498. *Ex* Hemprich and Ehrenberg MSS. Red Sea. *Id.* Hemprich and Ehrenberg, Symb. Phys., 1899, Zool., pl. ii.; Zoot., pl. x.—*vide* Garman.

Manta ehrenbergi Barnard, Ann. S. Afr. Mus., xxi., 1925, 87. *Id.* Anon., Rept. S. Afr. Mus., 1925 (1926), 7 and 10, fig. 2. *Id.* Barnard, Ann. S. Afr. Mus., xxi., 2, 1927, 1015. *Id.* Biden, Lonsdale Library, xvii., 1934, Sea Fishing, 268 (Durban, 24½ feet across). *Id.* Fowler, Proc. Acad. Nat. Sci. Philad., lxxxvi., 1934, 409, figs. 2-3 (Embryo has teeth in both jaws. Natal).

Müller and Henle named this species after one of the authors of the "Symbolae Physicae", of which the part dealing with the Devil Ray is not available to me, but both Lloyd (1908) and Fowler (1927) comment on Hemprich and Ehrenberg's figure. The South African records quoted above are of considerable interest. See also Van Kampen's paper in Bull. Dépt. Agric. Indes-Neerl., xxxv., 1910, 9-13.

Subfamily INDOMANTINAE.

Genus INDOMANTA Whitley, 1936.

Indomanta Whitley, Austr. Mus. Mag., vi., 1, "January" [= February 21], 1936, 11. Haplotype, *I. tombazi* Whitley.

In The Australian Museum Magazine, I wrote . . . "*Indomanta* is a hitherto unnamed Giant Bat Ray, 22 feet wide and with teeth in upper and lower jaws. It has but recently been described from off Karachi, India, by Tombazi*, after whom it may be named *Indomanta tombazii*".

*Tombazi, Journ. Bombay Nat. Hist. Soc., xxxvii., 1934, p. 227 and pl.

INDOMANTA TOMBAZII Whitley.

Dicerobatis eregoodoo Tombazi, Journ. Bombay Nat. Hist. Soc., xxxvii., 1934, 227 and pl. Cape Mouze, 20 miles from Karachi, India. Not *D. eregoodoo* Cantor, 1850.

Indomanta tombazii Whitley, Austr. Mus. Mag., vi., i., 1936, 11. New name for Tombazi's species.

A Giant Indian Bat Ray, 22 feet wide and 17 feet from head, excluding cephalic fins, to tip of tail. Teeth in both jaws.

Tombazi states:—"Teeth small, file-like, extending practically the full length of the mouth; I counted seven rows of these on the lower jaw and six on the upper."

The tail bears a spine.

Weight estimated at four or five thousand pounds.

Vernacular name: *Karanj*.

Family MOBULIDAE.

Smaller Devil Rays with the mouth less extensive and situated well underneath the head. Cephalic fins frequently rolled outwards. The typical species is the Mediterranean *Mobula edentula*, but the "Eregoodoo" (*M. diabolus*), from Indian Seas and extending its range to Queensland, is also well known. Many nominal species have been described from various parts of the world and are listed hereunder, but it is possible that they are not all of equal status and further revision of them is desirable.

Two subfamilies:—

Teeth on both jaws—*Mobulinae*.

Teeth on upper jaw only—*Ceratobatinae*.

Subfamily MOBULINAE.

Genus MOBULA Rafinesque*, 1810.

Mobula Rafinesque, Ind. Ittiol. Sicil., May, 1810, 48 & 61. Haplotype, *M. auriculata* Rafinesque—*fide* Sherborn, Index Anim.

Apterurus Rafinesque, Ind. Ittiol. Sicil., May, 1810, 62. Type, *Apterurus fabroni* Rafinesque—*fide* Jordan, Gen. Fish.

Cephalopterus Risso, Ichth. Nice, 1810, 14. Two species: *Raia giorna* Lacépède and *Cephalopterus massena* Risso. Logotype, *Raia giorna* Lacépède, selected by Bancroft, Zool. Journ., iv., 1829, 452.

Name preoccupied by *Cephalopterus* Geoffroy, Ann. Mus. Hist. Nat., Paris, xiii., March, 1809, 238, a genus of birds.

Dicerobatus Blainville, Bull. Sci. Soc. Philom., Paris, July, 1816, 120; Journ. de Physique, 1816, 262—*fide* Sherborn. Type, *Raia mobular* Bonnaterre.

Cephaloptera Cuvier, Regne Anim., ed. 1, ii., "1817" = December, 1816, 138. Attributed to Duméril, but actually feminine of Risso's genus. Tautotype, *Raia cephaloptera* Bloch and Schneider. *Id.* Fleming, Phil. Zool., ii., 1822, 378 (*fide* Sherborn) and of Gunther, Muller and Henle, Rüppell, etc.

Dicerobatis Blainville, Faun. Française (Poissons), April, 1825, 40—*fide* Sherborn. Bancroft selected *Raia fimbriata* Lac. [= *Manta*] as type.

Apturus Cuvier and Valenciennes, Hist. Nat. Poiss., i., 1828, 215. Equivalent to *Apterurus* *ibid.*, 195, *ex* Rafinesque.

*As early as 1803 Bosc (Nouv. Dict. Hist. Nat., ed. 1, xix., 1803, 178) wrote " . . . espèces si monstrueuses sont dans le cas peut-être de former un genre particulier".

Pterocephala Swainson, Nat. Hist. Fish. Amphib. Rept., ii., July, 1839, 192 and 321. Haplotype, *Raia giorna* Lacépède.

Diarobatus Agassiz, Nomencl. Zool., Pisces, 1845, 22. *Id.* Cantor, Journ. Asiat. Soc. Bengal, xviii., 2, 1850, 1419, and Cat. Malay Fish., 1850, 437, attributed to Bloch! Obviously an error for *Dicerobatis* Blainville.

Horned Rays, generally much smaller than *Manta*, and having the mouth below the anterior part of the head. They have been noted from the Mediterranean, particularly, since classical times.

MOBULA EDENTULA (Brunnich).

Squalus edentulus Brunnich, Ichth. Massiliensis, 1768, 6, No. 14. Marseilles, France.

Raia mobular Bonnaterre, Tabl. Encycl. Meth. (Ichth.), 1788, 5. Mediterranean.

Raja vespertilio Donndorff, Zool. Beytr., iii., 1798, 876. [Marseilles.]

Raja fabroniana Lacépède, Hist. Nat. Poiss., ii., 1800, 104, pl. v., figs. 1-2. Livourne, Mediterranean.

Raja manatia Bloch and Schneider, Syst. Ichth., 1801, 364. Based on the "*Raie manatia*" of Lacépède, Hist. Nat. Poiss., i., 1798, 160, pl. vii., fig. 2, vernac. from equatorial America, which is described as having the mouth well behind anterior end of head.

Raja cephaloptera Bloch and Schneider, Syst. Ichth., 1801, 365. Pacific, etc.

Raja giorna Lacépède, Hist. Nat. Poiss., v., 1803, 662. Nice.

Aodon cornutus Latreille, Nouv. Dict. Hist. Nat., xxiv., 1804, 72. Based on the "*Aodon cornu*" of Lacépède, Hist. Nat. Poiss., i., 1798, 297, vernac.

Id. Daudin, Dict. Sci. Nat., ii., 1816, 265. Equivalent to *Squalus edentulus* Brunnich.

Mobula auriculata Rafinesque, Ind. itt. Sicil., 1810, 48 & 61—*fide* Sherborn, Index Anim.

Apterurus fabroni Rafinesque, Ind. itt. Sicil., 1810, 48. *Ex Raja fabroniana* Lacépède—*fide* Sherborn.

Cephalopterus massena Risso, Ichth. Nice, 1810, 15. Nice.

Only the primary specific references to synonyms are given in the above synonymy. This species has also appeared in a vast and scattered literature as, amongst other names, *Cephalopterus giorna*, *Dicerobatis mobular*, *Dicerobatis giornae*, *Cephaloptera fabroniana*, *Mobula mobular*, *Cephaloptera edentula*, etc. There are a number of papers on the anatomy of this species, many of them unfortunately not accessible to me.

I have already given, *supra* under *Aodon*, a copy of Brunnich's original description.

MOBULA DIABOLUS (Shaw).

Raja diabolus Shaw, Gen. Zool., v., 2, 1804, 291. Based on the "Eregoodootenkee" of Russell, Fish. Vizagapatam, 1803, 5, pl. ix., Vizagapatam, India (type) and Saint Helena. *Id.* Swain, Proc. Acad. Nat. Sci. Philad., 1882 (1883), 308.

Dicerobatis eregoodoo Cantor, Journ. Asiat. Soc. Bengal, xviii., 2, 1849 (1850), 1420; Cat. Malayan Fish., 1850, 438. Coromandel and Sea of Penang. And of later writers, *ex* Cuvier, vernac.

Cephaloptera eregoodoo Duméril, Hist. Nat. Poiss., i., 2, Elasm., 1865, 655, pl. vi., figs. 2-5 (teeth).

Ceratoptera sp. Ogilby, Cat. Fish. Austr. Mus., i., Palaeich., 1888, 23. New Hebrides.

Dicerobatis eregoodoo Saville-Kent, Great Barrier Reef, 1893, 306, pl. xlviii., figs. 2-3. Palm Islands, etc., Queensland.

Mobula tenkee Jordan and Evermann, Bull. U.S. Bur. Fish., xxiii., 1903 (July 29, 1905), 51.

Mobula eregoodoo-tenkee Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi., 1913, 451. *Id.* Fowler, Copeia, 58, 1918, 62; Proc. Acad. Nat. Sci. Philad., lxxix., 1928, 256.

Mobula eregoodoo Ogilby, Mem. Q'ld. Mus., v., 1916, 90 and 95; *et ibid.*, vi., 1918, 97 (Moreton Bay, Q.). *Id.* McCulloch and Whitley, Mem. Q'ld. Mus., viii., 1925, 130. *Id.* McCulloch, Austr. Mus. Mem., v., 1929, 31.

Mobula diabolus Whitley, Austr. Mus. Mag., vi., 1, 1936, 6 and 11.

This is the Ox Ray or Smaller Devil Fish of Indian Seas, apparently extending its range to Queensland, from which State there are specimens in the Museum at Brisbane. The Australian Museum has an Indian example (No. B.3019) purchased from Dr. Francis Day. Russell's figures represent Indian and Saint Helena specimens, which may not be conspecific. Certainly the Saint Helena specimen differs from Saville-Kent's figure. Some of the remarks in Saville-Kent's text are doubtless referable to rays of the genera *Aëtobatis* and *Daemomanta*, rather than *Mobula*.

An immature female, four feet wide, mounted in the gallery of the Australian Museum, as *Aodon* sp. and without data may be the example catalogued by Ogilby in 1888. (In that case, it is No. I.1730 and came from the New Hebrides, having been purchased from Captain Braithwaite.)

However, it is now numbered I.5311, registered in May, 1902, as having no data. Mr. T. C. Roughley has photographed a Hayman Id. (Queensland) specimen.

MOBULA DRACO (Günther).

Dicerobatis draco Günther, Jottings Cruise Curaçoa (Brenchley), 1873, 412, pls. 26-27. Misol.

Mobula draco Van Kampen, Bull. Dépt. Agri. Indes-Néerl., xxxv., 1910, 9.

Well described and figured by Günther from Misol.

MOBULA MONSTRUM (Klunzinger).

Dicerobatis monstrum Klunzinger, Verh. Zool.-Bot. Ges. Wien., xxi., 1871; Syn. Fische Roth. Meeres, ii., 1871, 687. Red Sea.

An undoubted *Mobula*, described from a foetus, 54 cm. across the disc.

MOBULA KUHLLII (Müller and Henle).

Cephaloptera kuhllii Müller and Henle, Plagiost. (3), 1841, 185, pl. 59, fig. 1. Indian Seas. Name *ex Valenciennes* MS.

Cephaloptera kuhllii Duméril, Hist. Nat. Poiss., i., 2, Elasm., 1865, 654, *et seq.*, pl. vi., figs. 9-9a (teeth). Notes on type.

Ceratoptera kuhli Heeckeren Tot Waliën, Nat. Tijdschr. Ned. Ind. (9), v. or lvi., 1897, 30, pl. East Indies. *Id.* Vorderman, *ibid.*, 40-43.

Mobula kuhli Barnard, Ann. S. Afr. Mus., xxi., 1925, 86, pl. v., fig. 2. Original figure of S. African specimen which has shorter tail, smaller horns, etc., than those in Müller and Henle's figure.

Mobula kuhllii Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi., 1913, 452.

A nominal species from the East Indies, most likely a synonym of *M. diabolus*, only the original figure has a longer tail. Müller and Henle wrongly thought that the "Eregoodoo-tenkee" might have been the Brazilian *olfersii* = *hypostoma* and described *kuhllii* as a distinct species. Duméril remarks upon the type of *kuhllii* and regards the teeth as different from the "Eregoodoo-tenkee".

MOBULA HYPOSTOMA (Bancroft).

Cephalopterus hypostomus Bancroft, Proc. Comm. Zool. Soc., 1830, 134. Jamaica. *Id.* Bancroft, Zool. Journ., v., 1834, 411.

Cephaloptera olfersii Müller, Abh. Akad. Wiss. Berlin, 1834 (1836), 311. Brazil—skull described.

? *Cephaloptera massenoidea* Hill, Intell. Observer, ii., 1862, 176, 3 figs. Jamaica.

Mobula hypostoma Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi., 1913, 453, pl. xxxviii., figs. 1-6 (refs.) and anatomical figs. New York to Brazil.

Garman's beautiful figures were probably made from New York specimens, and for the Brazilian form, if distinct, the name *olfersii* is available, and has been employed as such by Coles (Copeia, 32, 1916, 45). An important paper on its dentition has been contributed by Gudger (Journ. Elisha Mitchell Sci. Soc., xlix., 1933, 92, pl. ii., figs. 1-4), who also recorded Coles' field notes in an earlier volume of the same Journal, February, 1913, 5. Pellegrin's paper (Bull. Soc. Philom. Paris (10), iv., 1912, 1-8) "Sur le dentition des Diablies de Mer" is not available to me.

MOBULA ROCHEBRUNI (Vaillant).

Cephaloptera rochebruni Vaillant, Bull. Soc. Philom. (7), iii., 1879, 187. Senegal. *Fide* Zool. Rec. *Id.* Rochebrune, Act. Soc. Linn. Bordeaux, vi., 1882, 1, pl. i., figs. 1-2.

The literature dealing with this species is unfortunately not available to me. Garman describes it as "Deep blue, with reddish on the frontal region, in a longitudinal band behind the head along the middle of the back, and on dorsal, ventrals, and tail. Rows of teeth, 50, occupying about half the width of the jaws.

Senegal.

MOBULA TARAPACANA (Philippi).

Cephaloptera tarapacana Philippi, Ann. Mus. Nac. Chile, i., 3, 1892, 8, pl. iii., fig. 2; Chilen. Fische, i., 1893, 9, pl. iii., fig. 2. Iquique, coast of Chile. *Id.* Gill, Smithsonian. Misc. Coll., lii., 2, 1908, 176.

A South American species which has, according to Philippi's figure, a remarkable "long-necked" appearance.

MOBULA THURSTONI (Lloyd).

Dicerobatis thurstoni Lloyd, Mem. Ind. Mus., ii., 1908, 179, pl. iv., fig. 2 and text-fig. 3. Madras, India.

Teeth separate, in 140 series, with upstanding cusps, unlike the low-lying ones of *diabolus*, extending nearly to the angle of the mouth. In lower jaw could not be counted, but apparently as numerous. Tail smooth, less in length than the disc, and without a spine. Proportions generally like *diabolus*, but cephalic fins relatively shorter. . . .

Based on a dried and shrunken specimen 160 cms. wide with a 53 cm. tail.

Madras.

MOBULA JAPANICA (Müller and Henle).

Cephaloptera japonica Müller and Henle, Plagiost. (3), 1841, 185. Japan.

Cephaloptera japonica Temminck and Schlegel, Faun. Japon., Pisces, 1850, 310. *Ex* Müller and Henle.

Dicerobatis japonica Günther, Cat. Fish. Brit. Mus., viii., 1870, 496. *Ex* Müller and Henle.

Mobula japonica Jordan and Evermann, Bull. U.S. Fish. Comm., xxiii., 1903, i., July 29, 1905, 50. Honolulu market (fragments only). *Id.* Jordan and Fowler, Proc. U.S. Nat. Mus., xxvi., 1903, 666, fig. 10. Misaki (foetus), Volcano Bay and Nagasaki, Japan. *Id.* Fowler, Bull. Bern. P. Bish. Mus., xxxviii., 1927, 3, pl. i., figs. A.-C. Honolulu market. *Id.* Fowler, Mem. Bish. Mus., x., 1928, 26.

A species recorded from Japan and Hawaii. The reference to *Mobula japonica* in Anderson's "Myths and Legends of the Polynesians", 1928, 392 and 479, doubtless refers to the Spotted Eagle Ray, *Aëtobatis*.

Jordan and Fowler (1903) figured a foetus and mentioned other Japanese specimens.

Fowler (1927) gave figures of the head of a Hawaiian adult with the following notes:—

"Honolulu market, July 17, 1924, 1 specimen. The first adult to be reported. Head width 320 mm., mouth width 200 mm. Teeth bands extend to mouth angles, 84 rows above, 101 rows below. Head above, dark dusky-brown; below, creamy-white. Eye pale. Edge of lower lip and upper edge of snout neutral grey, also inner surfaces of cephalic fins."

Subfamily CERATOBATINAE.

Genus CERATOBATIS Boulenger, 1897.

Ceratobatis Boulenger, Ann. Mag. Nat. Hist. (6), xx., August 1, 1897, 227. Haplotype, *C. robertsii* Boulenger.

This genus is compared with *Mobula*, but has teeth restricted to the upper jaw.

CERATOBATIS ROBERTSII Boulenger.

Ceratobatis robertsii Boulenger, Ann. Mag. Nat. Hist. (6), xx., August 1, 1897, 227. Jamaica. *Id.* Gill, Science (2), xviii., 1903, 473—*vide* Zool. Rec. *Id.* Gill, Smithsonian Misc. Coll., lli., 2, 1908, 176. *Id.* Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi., 1913, 454.

Known only from the type. Width of disc, 780 mm. Mouth inferior, wide.

EXPLANATION OF PLATE XII.

Daemomanta alfredi (Kreffit). Views of a specimen, 11 ft. 8 in. wide, from Maher Island, Cumberland Group, Queensland.

Fig. 1. Upper surface of tail showing lack of spine or bony boss.

Fig. 2. Lower surface of tail showing naked base and low fold.

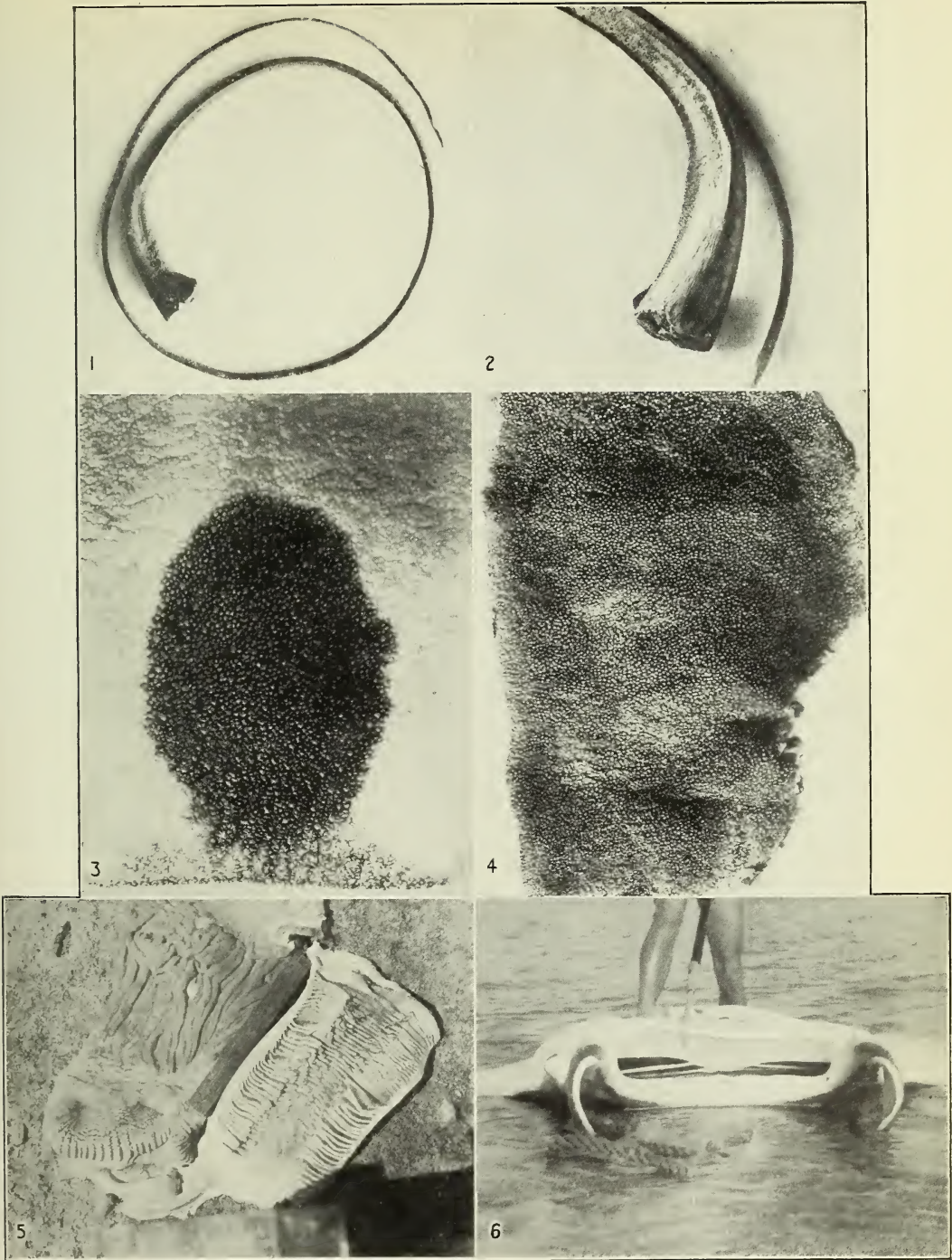
Fig. 3. One of the dark spots on the belly, showing denticles of the skin.

Fig. 4. Shagreen from the dorsal surface.

Fig. 5. The alimentary canal cut open along its entire length (see also text-figures).

Fig. 6. Mouth-opening, seen from the front, the ray lying on its back.

Photos by G. C. Clutton (1-4) and M. Ward (5-6).



THE DEVIL RAY.

(See explanation on p. 188.)